Hip dysplasia research at Ghent University; towards a new approach to asses hip quality?

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ABSTRACT

Canine Hip dysplasia (CHD) is a genetically defined predisposition of the hip articulation of the dog that increases the risk of developing degenerative joint disease (DJD). So far, the genetic background of HD has not been identified. Therefore, the genetic trait is being traced by radiological techniques. These will reveal the HD-phenotype, which is characterised by lack of congruency and excessive laxity of the hip-articulation, and ultimately by signs of DJD.
Hip radiographs of satisfactory technical quality were selected belonging to 2 groups: a first group (n=22) without any sign of DJD (FCI score A or B or C1), and a second group (n= 18) with undisputable but low level DJD (score C2) and digitalised. Several measurements of the hips were assessed using the conventional calliper method, and by means of an image analysing program (Digimizer®). Also, repeat measurements were performed at different moments in time. Statistical analyses used the Medcalc® software, Mariakerke, Belgium. Using the Digimizer® system, it was found that measurement of the Norberg angle has a reasonable reproducibility of 2% (coefficient of variation, C.V.), whereas the C.V. using the conventional callipers was 4%. In spite of its more precise and reproducible measurement using the Digimizer, the NA had only moderate power to discriminate between hips with or without degenerative joint disease. The Digimizer® allows for the accurate measurement of area surfaces, and it was found that the area surface of the non-covered part of the femoral head (NC-FH), standardised for the size of the dog, has the strongest power in discriminating between hips with or without degenerative disease. Since this variable is related to both the anatomical configuration of the hip articulation, and laxity, it may well be a very useful parameter for inclusion into the flow chart of hip dysplasia scoring. Further studies are needed on a larger number of dogs of different breeds to confirm our preliminary conclusions.

INTRODUCTION

Canine hip dysplasia (CHD) is an abnormal development of the hip joint. Laxity is increased, hips are partially or totally luxated, the femoral head is abnormal and deformed and finally osteo-arthrotic changes become visible. It is a multi-factorial disorder, meaning both genetic and environmental factors influencing the outcome of the disease.
Final scoring is based on subjective evaluation of subtraits and on measurement of certain morphological traits of the hip joint. Measurable traits are the Norberg Angle, the absolute distance of the femoral head centre to the dorsal acetabular edge and the femoral coverage, being the part of the femoral head that is covered by the acetabulum. All three are mentioned in literature and used as help in scoring hip quality. Although these are measurements, they are often estimated. One of the reasons is that there are no tools available to measure e.g. the femoral coverage being a non linear measurement. Also, with the oncoming digital era, measuring will only be possible using adequate software.
In this study, we report the measuring of traits related to the quality of hips using a specially designed image analysing program. We measured not only the traits reported in literature and used as reference in scoring hips, but also some new ones.

METHODS AND MATERIALS

At first, radiographs of sedated dogs that were either positive or negative for degenerative joint disease (DJD), were looked for. Only radiographs of acceptable radiological quality (see fig 1) and positioning (see left radiograph fig 2) were retained. This was done because difference in positioning can affect measurements, as is visible in the figure 2, showing two radiographs of the same dog with a different position.

Figure 1; On the above radiograph, the subchondral acetabular bone is clearly visible, as does the epiphyseal growth plate. One needs to see these lines to be able to perform the different measurements. The other radiographs lacks sufficient contrast and can not be used for measuring. It therefore should be rejected by the scrutineer(s).

Figure 2; the left radiograph is not acceptable because the femora are not parallel to the body ax. Because of that, subluxation can be underestimated

Eighteen dogs showed low levels of DJD, while 22 did not. The 22 dogs did not show a perfect hip quality with some of them showing subluxation. All radiographs were digitalised using a digital camera (Eos Canon®). Sixteen different measurements were performed on all radiographs using Digimizer®. The angle (2) and linear (12) measurements were performed using conventional callipers. Seven of these measurements can be considered as laxity insensitive, such as the acetabular depth or laxity sensitive such as the Norberg Angle. All measurements but the angle measurements were relative measurements. By doing so, differences in size of the dog and of pixels were corrected. This correction was done using the distance between the both tubera ishiadica, being the best reproducible measurement (CV = 0.172 %).
All data were statistically analysed. Statistical analyses used the Medcalc® software, Mariakerke, Belgium.

RESULTS

It was clear out of the statistical analysis (ROC – curve analysis) that the laxity insensitive measurements had no significant influence on the presence or absence of DJD. Only some of the laxity sensitive measurements, such as the Norberg angle (Fig 3), the relative distance between the femoral head centre and the dorsal acetabular edge (Fig 4) and the non - covered part of the femoral head, (linear, perimeter and area; Fig 3 and 5) are capable to discriminate between hips with or without signs of DJD, as can be seen in table 1.
Additional results show that using digimizer®, the CV for measuring the Norberg Angle decreases to 2 % compared to the 4 % when using conventional callipers. The CV for NC-FH² is 9 %.

Figure 3 shows the Norberg Angle measurement (left and right hip) and the non covered part o fthe femoral head (left – blue).

Figure 4; on the right hip, the joint space is marked as well as the femoral head centre (FHC). The middle line of the joint space is located and the distance between the FHC and this middle line is measured.

Figure 5; Linear, perimeter and area measurements of the non covered part of the femoral head

	CO-value	specificity	sensitivity	prevalence = 20 % false + (%)	false - (%)	NPV	prevalence = 30 % false + (%)	false - (%)	NPV	prevalence = 40 % false + (%)	false - (%)	NPV
NA-L (°)	< 100,6	77,3	55,6	18,16	8,88	87,44	15,89	13,32	80,25	13,62	17,76	72,31
NA-R (°)	< 98,96	81,8	55,6	14,56	17,76	88,05	12,74	13,32	81,13	10,92	17,76	73,43
FHC-J-L	> 0,035	59,1	83,3	32,72	6,68	93,40	28,63	5,01	89,20	24,54	6,68	84,15
FHC-J-R	> 0,04	90,9	50	7,28	20,00	87,91	6,37	15,00	80,92	5,46	20,00	73,17
NC-FHL-L	> 0,071	72,7	83,3	21,84	6,68	94,57	19,11	5,01	91,04	16,38	6,68	86,72
NC-FHL-R	> 0,19	59,1	83,3	32,72	6,68	93,40	28,63	5,01	89,20	24,54	6,68	84,15
NC-FHA-L	> 0,234	95,5	50	3,60	20,00	88,43	3,15	15,00	81,67	2,70	20,00	74,13
NC-FHA-R	> 0,198	59,1	83,3	32,72	6,68	93,40	28,63	5,01	89,20	24,54	6,68	84,15
NC-FH²-L	> 0,0024	77,3	66,7	18,16	13,32	90,28	15,89	9,99	84,41	13,62	13,32	77,69
NC-FH²-R	> 0,0024	77,3	66,7	18,16	13,32	90,28	15,89	9,99	84,41	13,62	13,32	77,69

NPV = the probability that the disease is absent if the test result is negative

Table 1; Cut – off values, specificity, sensitivity and distracted values for the different retained measuerements. FHL = linear; FHA = perimeter; FH² = area

DISCUSSION and CONCLUSION

Digimizer® is a very useful tool. It allows not only to measure with a higher reproducibility, but also to measure areas and perimeters which can not be achieved with conventional callipers. Another interesting feature is the possibility to obtain corrected measurements immediately. Literature always reports absolute, non - corrected measurements.

The Norberg Angle can discriminate between hips with or without DJD, but all measurements related to the non - covered part are equal or even better discriminators. The Norberg angle represents the level of luxation and the depth of the acetabulum. The non - covered part represents the luxation level, the depth of the acetabulum and the relation between the shape of the femoral head and the acetabulum, making this the possible explanation for the better discrimination.

Although the non - covered measurements are better discriminators, false negatives and false positives are still found. As a consequence, some breeding animals are accepted and should be refused, while sometimes many more are refused and should have been accepted. Therefore, additional parameters or repeated screening sessions are needed to decrease the amount of false positives and false negatives. Screening for DJD at two years and five years might be an option to consider. Dogs showing no DJD should be considered as negative.

The fact that only laxity sensitive measurements can discriminate between hips with or without DJD stresses the importance of laxity in canine hip dysplasia. Whether laxity is the cause or a consequence remains unclear.

Further studies are needed on a larger number of dogs of different breeds to confirm these preliminary conclusions. The study will especially focus on the question whether a higher sensitivity and specificity can be obtained if one focuses on radiographs of superb quality that were obtained from dogs uniformly and deeply (= high rate of muscle relaxation) sedated.